ALTERATIONS IN CEREBRAL LATERALITY WITH EMOTION AND PERSONALITY TYPE IN A DICHOTIC LISTENING TASK

Mark Edward Servis

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ABSTRACT

ALTERATIONS IN CEREBRAL LATERALITY WITH EMOTION AND PERSONALITY TYPE IN A DICHOTIC LISTENING TASK

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Dichotic listening tests with positive and negative affect words were used to measure changes in the magnitude of perceptual asymmetry in 40 right handed subjects as a function of emotional state and personality type. Four different affect tests were administered to repressive, high anxious and low anxious personality types: neutral affect, positive affect, negative affect, and combined positive and negative affect. An increase in perceptual asymmetry with positive affect was observed in all three personality types. A decrease in perceptual asymmetry with negative affect was observed in low anxious personality types, but an increase was observed for repressive and high anxious personality types. These findings support the differential lateralization of emotion, with positive affect associated with the left hemisphere and negative affect with the right hemisphere. The pattern of these results also suggests a biphasic response to affective stimuli dependent on personality type; with a functional interhemispheric disconnection for repressive and high anxious personality types, and a unilateral hemispheric activation and

contralateral inhibition dependent on the type of emotion for low anxious personality types.

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INTRODUCTION

The effort to elucidate the normal and pathological structure and function of the human brain has historically progressed along three main paths or perspectives in psychiatry: neuroanatomy, neurochemistry, and psychological theories of the mind. A fourth perspective now presents as a reliable and useful alternative to these traditional approaches: studies in cerebral laterality. Investigations of cerebral laterality now form the basis of a conceptual approach to the brain that is independent of psychological theory and focuses on a higher level of organization and function than present studies in neurochemistry and neuroanatomy. Research in cerebral laterality can directly assess both brain function and dysfunction and probe the interactions of different brain regions. Such investigations may provide a more functionally accurate classification and understanding of psychiatric disorders.

Lateralization of Cognitive Function

That the two sides of the brain are functionally and anatomically different has been known since the post-mortem examinations of the brains of aphasic patients by Broca in 1861. One of Broca's discoveries was the observation that the form of aphasia to which his name was subsequently attached resulted from left unilateral lesions of the temporal lobe (1). Since then the cerebral hemisphere which primarily controls language capability,

usually the left, has been designated the "dominant" hemisphere. Nevertheless, more recent investigations of neurologic patients with other types of unilateral lesions have shown the non-dominant hemisphere superior for certain aspects of higher cortical cognitive function. These cognitive specializations include maze learning, face recognition, and other tasks involving spatial analysis (2-4). Other studies of neurologic patients have found the left temporal lobe, anterior to the speech region, essential for verbal memory, and the left frontal lobe necessary for word fluency (3,5). The concept of cerebral dominance, therefore, becomes precise only when we consider a particular hemisphere dominant for a specific function.

These findings of cerebral specialization for certain functions have been confirmed in another group of neurologic patients; those who have had surgical sectioning of their interhemispheric connections in an effort to control intractable, incapacitating epileptic seizures. The two hemispheres are normally connected by the anterior commissure and the corpus callosum - the largest fiber tract in the human brain. Since the major interhemispheric pathways in these split-brain patients have been disrupted, it is possible to evaluate the functional characteristics of each hemisphere by selectively presenting test stimuli to the left or right sensory field. Since the majority of peripheral sensory receptors project to the contralateral side of the brain, the cerebral processing of these stimuli is confined to the hemisphere contralateral to the site of presentation. When stimuli are presented exclusively to the non-language hemisphere, usually the

right, split-brain subjects are able to spell and recognize simple words, but are unable to speak or comprehend sentences or identify nonsensical phonemes (6,7). When stimuli are presented exclusively to the language hemisphere, usually the left, split-brain subjects are impaired in their ability to do spatial tasks such as geometric pattern construction, maze learning, and tactile stereognosis (7,8). Split-brain subjects perform these tasks normally when stimuli are presented to the hemisphere specialized for that particular function.

Similar studies with healthy subjects, when test stimuli are confined to the right or left sensory field, have produced findings consistent with the lateral specialization found in neurologic patients. Normal subjects more readily recognize stimuli presented in the sensory field contralateral to the hemisphere specialized for their processing, resulting in a small perceptual asymmetry. Thus, words and letters are more quickly and accurately recognized in the right sensory field, and faces and dot location more quickly and accurately perceived in the left sensory field (9-16). The perceptual asymmetry or difference between hemispheres observed, however, is much smaller in normal subjects than in neurologic patients after commissurotomy. The small interhemispheric differences in normal subjects probably result from the delay and decay of information during transmission from the non-specialized to the specialized hemisphere; while in split-brain subjects stimuli necessarily undergo independent parallel processing in two differently specialized hemispheres - generating rather large differences in perception. The delay and

decay of information in the interhemispheric transfer probably results from the limited number of projections from association areas surrounding the primary receptive regions to the corpus callosum and anterior commissure, compared to the more numerous intrahemispheric projections from primary receptive and association areas to the specialized processing areas. In addition, the interhemispheric pathway probably involves more synapses than the direct pathway from peripheral receptor to specialized hemisphere.

Studies of neurologic patients with unilateral brain lesions have confirmed the role of interhemispheric transfer in normal perceptual asymmetry. Patients with left hemispheric lesions demonstrate a reduction in the recognition of language related stimuli presented to both sensory fields, while patients with right hemispheric lesions demonstrate deficiencies only in the recognition of stimuli presented to the left sensory field (17-20). In another example, partially aphasic patients with left temporal lesions demonstrate a left sensory field advantage on language related stimuli, in contrast to the usual right sensory field advantage seen in normal subjects. Since it is unlikely that final language processing shifts from the left to the right hemisphere, such a change in perceptual advantage is probably due to left hemisphere disruption of normal processing pathways, resulting in a greater delay or decay of information than exists in the transcallosal pathway of sensory information from the right hemisphere (21).

Measurements of Perceptual Asymmetry

Numerous other studies have examined cognitive cerebral specializations using a wide variety of direct and indirect measures of cerebral asymmetry, including neuropsychological testing, dichotic listening, lateral eye movements, skin conductance responses, EEG recordings, CT scans, and regional cerebral blood flow. Such investigations have confirmed the relative specialization of one hemisphere, usually the left, for language functions, and the other hemisphere for processing spatial relationships. Each hemisphere, functioning independently in split-brain subjects, is capable of low-level performance on tasks for which it is not specialized. When interhemispheric connections are intact, however, each hemisphere transmits information from stimuli for which it is not specialized across to the specialized hemisphere for processing. A perceptual asymmetry results due to the delay and decay of information following the longer and more limited neural pathway from peripheral receptor to the non-specialized contralateral hemisphere and across the corpus callosum to the specialized hemisphere for processing. The more readily perceived peripheral sensory field gains its perceptual advantage by virtue of a more direct access to the hemisphere specialized for processing the stimuli.

Identification of stimuli presented selectively to right and left peripheral fields depends then on the function of the primary, and possibly the secondary and tertiary, receptive and association areas in each hemisphere, the transmission of

information across the cerebral commissures, and the function of specialized processing areas. Test stimuli, known to be processed in a particular hemisphere, can therefore be used as sensory probes, following roughly identifiable neural pathways in the brain. Such probe stimuli can evaluate the function of the specialized and non-specialized hemispheres, the interactions of different receptive and association areas, and the transfer of information interhemispherically. Concurrent physiologic and cognitive factors can also be used to assess brain function and map cerebral space by their alteration of perceptual asymmetry. Changes in stimulus context, perceptual distortion, alcohol administration, and competing cognitive tasks have all been shown to alter an individual's degree of perceptual asymmetry (15,22-27). These dynamic factors may represent such brain states and interactions as unilateral hemispheric activation, unilateral hemispheric inhibition, neural pathway competition, and interhemispheric inhibition.

Alterations in the magnitude or direction of perceptual asymmetry can therefore be used as markers of change in hemispheric action or interaction during normal and pathological functioning. An application of this strategy by Wexler and Hawles, using dichotic auditory stimuli to measure perceptual asymmetry, has proven useful in collecting data that can be utilized in the mapping of cerebral functional space (27). Dichotic listening tests, where different verbal stimuli are presented simultaneously to both ears, are particularly powerful and reliable when making the contextual concurrent manipulations

necessary for such an approach.

In healthy individuals, monaural input to either ear is represented in both cerebral hemispheres, with a small advantage for contralateral over ipsilateral pathways (28,29). When different stimuli are presented simultaneously to both ears during dichotic listening, the weaker ipsilateral pathways are suppressed by the stronger contralateral pathways. Primary evidence for this comes from studies of split-brain patients during dichotic listening tasks. These patients have no difficulty reporting words or consonant-vowel syllables presented monaurally to either ear, but when the same stimuli are presented dichotically, they fail to report stimuli presented to the left ear (30-33). In support of this finding, researchers have found that with the dichotic presentation of identical stimuli, the ipsilateral cortical evoked response shows a longer latency than the contralateral evoked response (34). That ipsilateral inhibition is at least partially central in origin is supported by the finding that the extent of loss of ipsilateral inputs with dichotic stimulation of split-brain subjects is three times greater in stimulus pairs that differ in two phonetic features than in pairs that differ in only one phonetic feature (33). The loss of ipsilateral inputs also depends greatly on the degree of spectral and temporal auditory overlap, and is directly proportional to the degree of such similarity between stimulus pairs (35).

Studies demonstrating the validity of dichotic tests in normal

subjects have compared predictions of hemispheric language dominance based on dichotic ear asymmetry with the degree of dysphasia following invasive methods such as unilateral ECT or intra-carotid sodium amytal injection. A 95% correspondence between these measures of language laterality has been found (36-38). Further evidence for the validity and sensitivity of dichotic measures is found in studies where perceptual asymmetry scores were subjected to a criterion of statistical significance before classifying subjects as right or left hemisphere dominant. Dextrals were found on two seperate tests to be 93% and 97% right ear and left hemisphere dominant. In contrast only 70% of sinstrals showed right ear advantages (39,40). These findings are consistent with the incidence of left hemisphere language specialization found in studies of right and left-handed neurologic patients. Clearly dichotic listening tests, properly constructed and evaluated, are a reliable measure of perceptual asymmetry, conforming to the pattern of stimulus processing and subsequent asymmetry described earlier; where subjects more readily recognize verbal stimuli presented to the ear contralateral to the language specialized hemisphere.

Lateralization of Emotion

Current research in cerebral laterality has uncovered the cerebral specialization of not only cognitive functions, but of affective states or emotion. The earliest suggestions of a differential hemispheric mediation of affective processes came from clinical observation. Goldstein was the first to observe a

common emotional response to left hemisphere lesions he called a "catastrophic reaction." Patients displayed feelings of despair, hopelessness and anger and exhibited periods of self-deprecation, compensatory boasting and fits of crying (41). In contrast, patients with right hemisphere lesions usually exhibit an "indifference reaction" characterized by a minimization of symptoms, emotional placidity, joking, elation and social disinhibition (42). Similar responses have been reported during unilateral intra-carotid injection of sodium amytal, with right-sided injection often producing inappropriate silliness and euphoria (43). These patterns have been confirmed by Gainotti in a study of 160 patients with lateralized brain damage. Gainotti thought that the catastrophic reaction in patients with left hemisphere damage was basically a normal response to a serious deficit in physical or language associated cognitive function. However, he felt that the indifference reaction was probably an abnormal and inappropriate affective response, associated with an implicit denial of illness. Gainotti speculated that the right or non-dominant hemisphere was important in mediating emotional processes (42).

A number of studies of cerebral lateralization in normal subjects have supported a right hemisphere specialization for processing of emotional stimuli. In a listening experiment with normal subjects, Haggard and Parkinson found that judgements about the emotional tone (angry, bored, happy, distressed) of sentences, which were dichotically presented in competition with continuous babble, were significantly more accurate on left ear presentation

(44). Carmon and Nachshon used a dichotic procedure to find a slight left ear advantage for the recognition of nonverbal, emotional human voices (45). Safer and Leventhal found that subjects were more likely to respond to the emotional tone of a message when it was presented monaurally to the left ear than when it was presented to the right ear (46). These findings are consistent with the observation that patients with right hemisphere damage have an auditory affective agnosia; an inability to discriminate between neutral and affective intonations of a given sentence (47,48).

Studies using brief lateralized tachistoscopic presentations have also indicated a right hemisphere advantage for the processing of emotional stimuli. Suberi and McKeever asked subjects to match unilaterally presented faces to previously memorized target faces as rapidly as possible. Subjects who had memorized emotional faces showed a stronger than usual left visual field advantage in face recognition than subjects who had memorized neutral faces (49). A similar study by Ley and Bryden found a left visual field superiority in the recognition of emotional expression during tachistoscopic presentation; a finding replicated in a study by Safer (50,51). Schwartz and co-workers recorded lateral eye movements and found that subjects responded to questions with affective content by turning their eyes to the left, while subjects responding to non-emotional questions tended to look to the right (52). According to the rationale of lateral eye movement studies, these results indicate greater right hemisphere activation with emotional stimuli.

The implication of the right hemisphere in affective illness has also received attention, with studies generally indicating some kind of right hemisphere dysfunction in depression (53). There have been a number of studies of lateralized hemispheric function in depressed patients; using such measures as dichotic listening tests, visual evoked potentials, skin conductance, lateral eye movements, EEG, and clinical neuropsychological tests. While Flor-Henry reported EEG data to support his hypothesis of right hemisphere dysfunction in depressed patients (54), Perris and his associates have interpreted their EEG and evoked potential data as evidence for left hemisphere involvement (55,56). Two studies have found lateral asymmetry in skin conductance responses of depressed patients indicating right hemisphere dysfunction (57,58). Additional support for the hypothesis of right hemisphere dysfunction in depression has been reported in clinical neuropsychological studies (54,59,60), while investigations of lateral eye movements give evidence suggestive of right hemisphere hyperactivity in depressed patients (58,61).

Though the results of these investigations seem to indicate a monopoly on affective processing and pathology by the right hemisphere, other more refined studies have suggested that the two hemispheres contribute differently to the experience and perception of emotion. Lateral eye movement investigations by Schwartz and co-workers found that positive affect (happiness, excitement) induced more right lateral eye movement and relative left hemispheric activation, while negative affect (fear, sadness) elicited more left lateral eye movement and right hemispheric

activation (62). These findings were replicated in two other studies of cerebral laterality looking at lateral eye movements and the measurement of asymmetries in facial expression by electromyography (63,64). Harman and Ray found that left hemisphere EEG amplitude showed larger increases during recall of positive emotional experiences then did right hemisphere EEG amplitude (65). In another study using EEG measures of cerebral laterality, Davidson and co-workers found greater left frontal lobe activity during positive affective states and greater right frontal lobe activity during negative affective states. They suggest that the left frontal lobe activity may be subcortical in origin and related to the left hemisphere's influence on fine motor control during approach behavior; while the right frontal lobe activity during negative affective states may also be subcortical in origin and associated with the right hemisphere's contribution to the more global and automatic motor activity of avoidance behavior (66). This interpretation of emotional lateralization, first presented by Galin (67), is appealing because it suggests that the observed affective difference in cerebral laterality may be organized subcortically and grounded in the fundamental approach versus avoidance behavior long studied by ethologists. From this perspective, positive emotions may be seen as the emotional concomitants of approach behavior mediated by the left hemisphere, while negative emotions may be seen as the emotional concomitants of avoidance behavior mediated by the right hemisphere. Thus the lateralization of emotion may be even more fundamental than the verbal-spatial lateralization of cognitive

function.

Further evidence for the differential lateralization of emotion comes from Dimond and Farrington who used heart rate as a measure of emotional response to unilaterally presented visual stimuli. They reported that heart rate was greater when unpleasant stimuli were presented to the right hemisphere compared to the left hemisphere. Heart rate was also greater when humorous stimuli were presented to the left hemisphere compared to the right hemisphere (68). Asymmetry in the voluntary expression of emotion was studied by Sackeim and Gur. They found that left-half face composites were judged more intense in their emotional display than right-half face composites in the expression of negative affect, but not in the expression of positive affect (69). Sackeim and associates also conducted a retrospective study of lesions associated with pathological laughter and crying, mood changes with hemispherectomy, and gelastic epilepsy. Their data suggest that the asymmetry in the regulation of emotion, with positive affect associated with the left hemisphere and negative affect with the right hemisphere, is consistent across the experience, processing, and expression of emotion. They hypothesize that the lateralization of emotion may reflect asymmetries in the content or response to particular neurotransmitters in the two cerebral hemispheres (70).

Repression/Cerebral Disconnection Hypothesis

A new dimension of research in cerebral laterality has linked the lateralization of emotion to characteristic differences in the

processing of emotional stimuli between individuals. Galin has suggested that a possible mechanism for the production of an apparent dissociation between verbal processes and affective awareness seen in some individuals may be the development of a functional disconnection syndrome between the two cerebral hemispheres. According to this model, individuals with a highly repressive coping style (denying anxiety, stress or conflict) may actually be attenuating the transfer of negative affective information from the right to the left hemisphere. Such an attenuation could account for their consistent verbal reporting of less negative affect than is evident on physiologic and behavioral measures. These self-denying individuals should demonstrate an increased lateralization of positive and negative emotion if the two cerebral hemispheres are functioning in a relatively disconnected manner (67,71,72).

Consistent with this hypothesis was the finding by Polonsky and Schwartz that the differential lateralization of positive versus negative emotion was greatest and most reliable in those subjects exhibiting a repressive coping style (73). They examined asymmetry in zygomatic and corrugator region muscle tension, those muscles involved with smiling and frowning respectively. They found relatively greater zygomatic muscle tension on the right side for positive stimuli, and relatively greater corrugator muscle tension on the left side for negative stimuli. These differences in laterality were strongest for subjects exhibiting high defensiveness and a repressive coping style. Individuals with low anxious, low defensiveness personalities showed virtually

no asymmetry as a function of affective stimuli. Further support for the relative attenuation of information transfer between cerebral hemispheres in repressive personalities has been found in lateral eye movement recordings, EEG alpha levels, and more direct measures of interhemispheric communication such as tachistoscopic presentations (74-76).

Rationale for Present Experiment

This present study utilizes a more direct measure of interhemispheric communication and cerebral processing in an examination of both the repression/cerebral disconnection hypothesis and the differential lateralization of emotion. A dichotic listening test using emotionally charged verbal stimuli is used as a measure of perceptual asymmetry and as a sensory probe along known neural pathways. Individual changes in perceptual asymmetry on dichotic listening tasks with neutral words, positive affect words, negative affect words, and positive and negative affect words in combination will be measured. The purpose of this experimental design is to create a consistent and reliable affective state in subjects during the adminsitration of dichotic tasks of similar cognitive load. The effect of affective state and personality type on the degree and direction of perceptual asymmetry will then be observed.

The apparent relative specialization of the left hemisphere for positive emotion and the right hemisphere for negative emotion should effect the processing of dichotic verbal stimuli in a consistent and predictable fashion. The hypotheses under

investigation in this study with left hemisphere language dominant individuals include:

(1) An increased right ear advantage with positive affective state as compared to the neutral affective condition. A result of left hemisphere activation and reciprocal transcallosal neural inhibition of the right hemisphere.

(2) A decreased right ear advantage with negative affective state as compared to the neutral affective condition. A result of right hemisphere activation and reciprocal transcallosal neural inhibition of the left hemisphere.

(3) An increased right ear advantage in repressive personality types as compared to non-repressive personality types, especially with emotionally charged stimuli, because of the interhemispheric inhibition of right hemisphere information transfer.

Auxillary goals of this study include examining the possible correlations and effects of age, sex, degree of handedness, tape order, and page of dichotic test with the degree and direction of perceptual asymmetry. Possible mechanisms for the observed changes in perceptual asymmetry will be advanced consistent with the known processing pathways used in dichotic stimulation and the cerebral architecture of emotional lateralization.

One of the methodological issues of prior studies using direct and indirect measures of perceptual asymmetry has been the differing cognitive load of positive and negative affective material. A variety of cognitive and environmental factors contribute to an individual's perceptual asymmetry performance. To minimize this interference and isolate the effect of affect the different dichotic affect tests used in this study were designed and modified in pre-testing to reduce error and create comparable

performance levels within and between experimental subjects. In addition, by looking at the interaction of affect and personality type this study will avoid a reliance on absolute measures of perceptual asymmetry. The neutral affect dichotic test will provide a baseline perceptual asymmetry performance for subjects against which the various affect states can be compared and evaluated. Relative changes in perceptual asymmetry across different personality groups should provide reliable and unassailable data for statistical analysis.

METHODS

Subjects

Forty Yale University students and employees (22 men, 18 women) between the ages of 17 and 51 served as paid participants after giving informed written consent. The mean age of subjects was 22.9 years. All were right-handed as determined by self-report and confirmed by a questionaire of manual asymmetry (77). None had siblings, children, or parents who were left-handed or with mixed hand dominance. Subjects were also screened for any hearing deficits, speech or language impediments, learning disabilities, psychiatric or neurologic illnesses, regular or heavy use of narcotic or psychoactive drugs, or use of any drugs significantly effecting the central nervous system 48 hours prior to testing. All subjects reported English as their first language. Subjects attended one experimental session which lasted approximately 75 minutes.

Stimulus

Perceptual asymmetry was measured with a dichotic fused rhymed-words test similar in format to that used by Wexler and Hawles (40). All stimuli were monosyllabic consonant-vowel-consonant words previously rated by a comporable subject population according to emotional or affective quality into one of three categories: neutral, positive, or negative. Dichotic pairs, differing only in their initial consonants, were then formulated and placed into one of four affect groupings: neutral:neutral

(e.g. gill:dill); positive:neutral (e.g. hug:tug); negative:neutral (e.g. died:bide); and positive:negative (e.g. best:test).

Natural speech recordings of the words were digitized on the PCM (Pulse Code Modulation) Computer System at Haskins Laboratories, acoustically modified, and then transfered to tape. The initial, distinctive portion of one member of each pair was cross-spliced onto the final, nondistinctive portion of the other member, making the final portions of the members of each pair acoustically identical (Figure A). Pairs were matched for similarity of pitch contour and modified for amplitude variability. The similarity of the dichotic stimuli in these and other acoustic parameters, along with the intrinsic timing accuracy of the Haskins PCM System in temporal alignment of stimuli, caused the dichotic pairs to fuse into a single auditory image. Despite the fact that subjects received different stimuli in each ear, subjects expected, experienced and reported only one response on each trial.

A number of the dichotic pairings were then pre-tested to assess for stimulus dominance, errors, and degree of auditory fusion. Stimulus dominance is the tendency for one member of a pair to be consistently reported independent of ear of presentation. Those pairs with consistently strong stimulus dominance across subjects do not contribute to the assessment of perceptual asymmetry since the response is identical regardless of which ear gets which stimulus. Such pairs were therefore

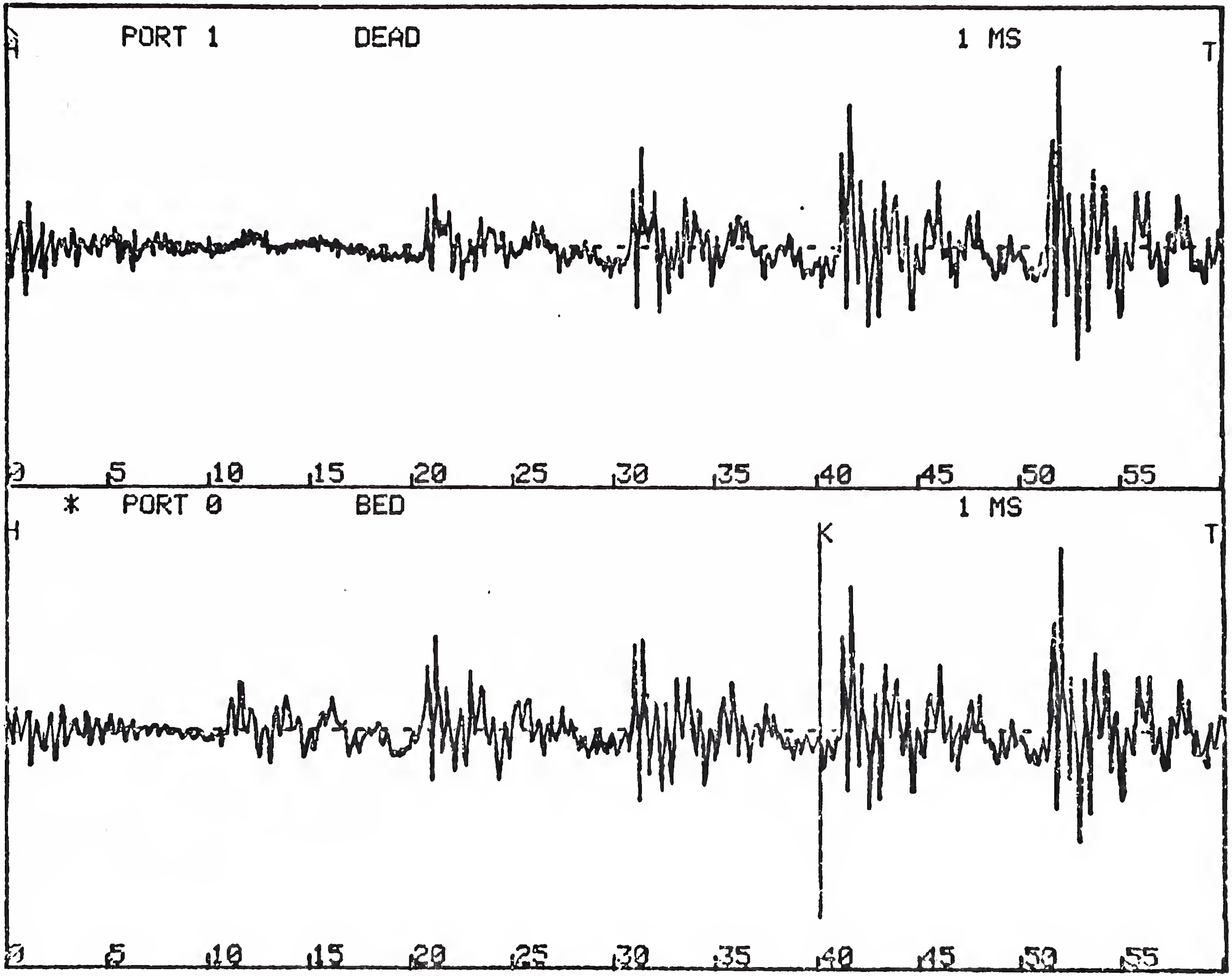

Figure A: Cross-splicing of end portion of "dead" to end portion of "bed"

identified and either discarded or modified by altering the timing or amplitude of some important acoustic parameter in one member of the pair (Figure B). Dichotic pairs which failed to present as acoustically fused images across subjects were likewise modified or discarded. Finally, pairs which generated a large number of errors or blend responses were also eliminated. Blend responses result when members of a pair differ in more than one phonetic feature and fuse to produce a response different from both of the original stimuli (gain:bane heard as dane). Such responses do not contribute to the assessment of perceptual asymmetry and were therefore eliminated when identified. These cumulative modifications led to a decrease in stimulus dominance, number of errors, and blend responses; and an associated increase in sensitivity to perceptual asymmetry in the final version of the test.

The final version of the dichotic test used eleven different dichotic pairs in each of the four affect conditions: neutral:neutral, positive:neutral, negative:neutral, and positive:negative. Each of the eleven dichotic pairs was presented twice in randomized 22 trial blocks, with the second presentation of each pair reversing the assignment of stimuli to ears given in the first presentation. Four such randomized 22 trial blocks were generated for each affect condition resulting in a total of 88 dichotic pairs per group. There was a 2.5 second interstimulus interval between pairs and an additional 12.5 second interstimulus interval between each of the four randomized 22 trial blocks.

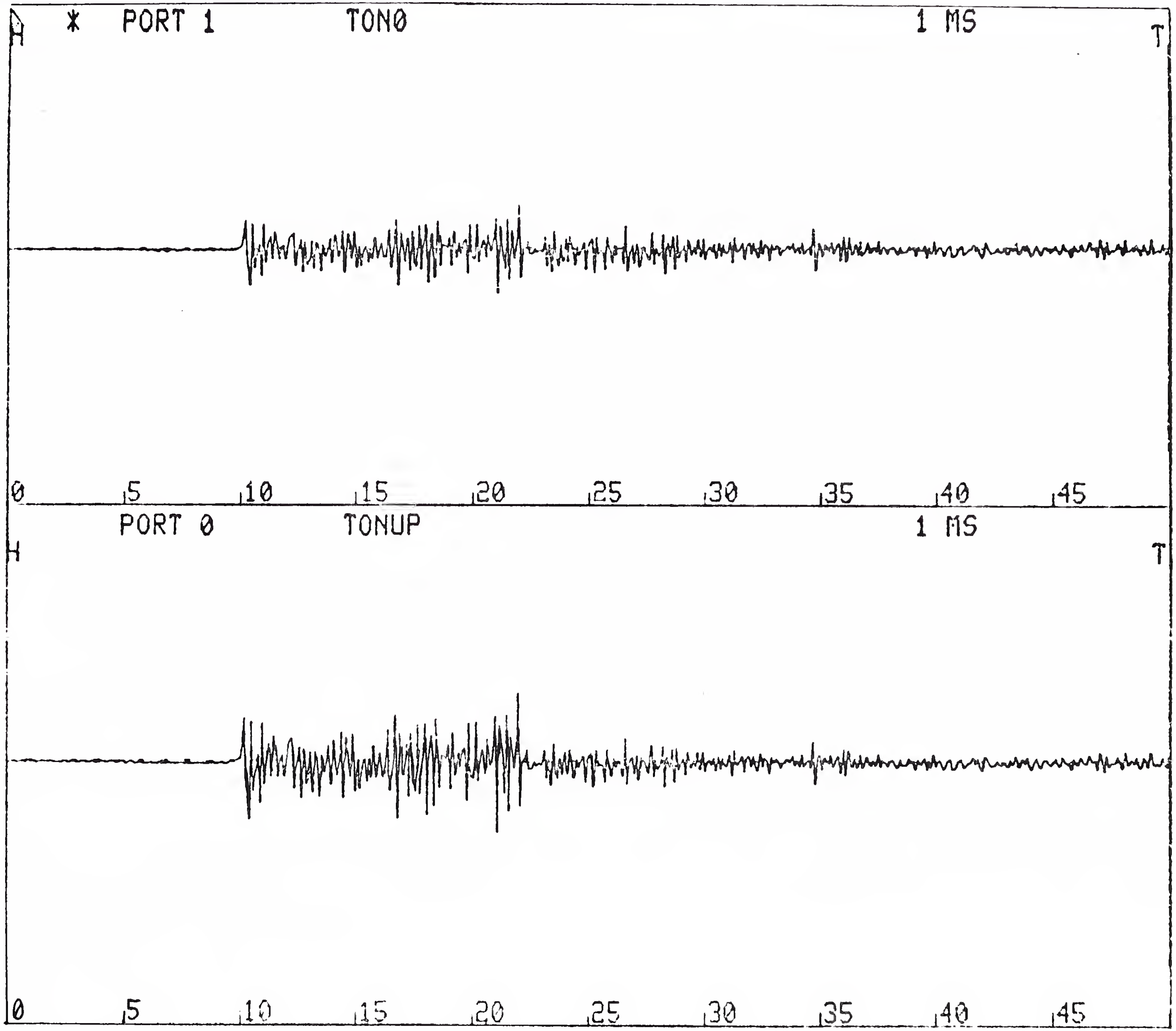

Figure B: Increasing amplitude of beginning portion of "ton" in tonup

Preceding each affect test was a practice segment where subjects became familiar with the test stimuli and their rate of presentation. Subjects listened to each of the 22 words presented binaurally, and were asked to check them off on a prepared list when they were heard correctly. A differently randomized 22 trial binaural list was then presented with the subjects selecting the word they heard from among four choices: the correct word, the other member of the pair, and two other words differing from the test pair only in their initial consonants. The corresponding 88 trial affect test was then presented with subjects choosing again from four possible responses: the members of the dichotic pair and two other words differing only from the test pair in their initial consonants. Subjects indicated responses by marking a line through one of the four possible choices on four pages of prepared answer sheets, each page corresponding to each 22 trial randomized block. Each of the four possible answer choices was randomized for sequence order across the page for all 88 trials (see Appendix A).

Procedure

Subjects began the sessions with the dichotic listening test to minimize any fatigue effect on perceptual asymmetry. The affect tests with their accompanying familiarization and practice procedures were presented in one of four orders: (1) negative:neutral, positive:neutral, positive:negative, neutral:neutral; (2) positive:neutral, negative:neutral, neutral:neutral, positive:negative; (3) positive:negative,

neutral:neutral, positive:neutral, negative:neutral; (4) neutral:neutral, positive:negative, negative:neutral, positive:neutral. The application of these four ordered sequences over 40 subjects resulted in an even distribution of affect conditions over the four possible positions in the testing sequence. All affect tests were given in a single session with a five minute rest between tests. Instructions were given only at the beginning of the first affect test, although an opportunity for questions between affect tests was provided. Subjects were instructed to choose the word they thought they heard from among the choices provided (see Appendix B). All subjects expressed suprise at the completion of the testing session when told they had been presented with more than one stimulus at a time.

The dichotic tapes were played on a professional quality, two-track TEAC stereo tape machine through a pair of stereo headphones matched for auditory response characteristics. Channel effects were minimized by using acoustically matched earphones and by balancing calibration tones on the tape with an audiometer at the beginning of each day of testing. Any remaining differences between the channels were controlled for by reversing earphone direction after the first and third quarters or pages of each affect test. In this design pages 1 and 4 and pages 2 and 3 of each affect test had identical earphone directions. Only properly marked answers were used in scoring. An error was scored when the subject did not report one of the two stimuli delivered on that trial. Mean accuracy rates for all four affect tests were greater than 95% during the administration of dichotic stimuli and greater

than 98% during the administration of binaural stimuli. In all, there were no large differences in error rate between affect tests that would significantly effect perceptual asymmetry performance comparisons between or within subjects. A laterality or perceptual asymmetry score was calculated by subtracting correct left ear responses from correct right ear responses, and dividing the difference by the sum of the right ear plus the left ear responses (R-L/R+L) (78).

Auditory acuity for all subjects was tested in each ear by determining ascending and descending thresholds for pure tones of 250, 1000, and 4000 Hz, following completion of the dichotic tests. No subjects had interear threshold differences of more than 10 dB at any frequency. Only 4 subjects had interear threshold differences greater than 5 dB, and these differences were only for one frequency.

A Questionaire of Manual Asymmetry (QMA) designed by McFarland was administered to each subject. The shorter 16-item version of the QMA was used (see Appendix C). The QMA measures left hand ability for performing tactile-spatial motor tasks and right hand ability for performing sequential motor tasks. It has been shown to be an accurate predictor for handedness (77). All subjects scored more highly on right hand ability. A handedness score was generated by subtracting the left hand score from the right hand score for each subject. The QMA was used because it provided an accurate and simple measure of cerebral laterality in a non-auditory dimension and also provided a convenient check for

handedness and cerebral dominance.

A 53-item personality scale, combining two seperate personality measures, was also administered to subjects (see Appendix D). The first personality measure was the Bendig (79) Short Form of the Taylor (80) Manifest Anxiety Scale. The short form items were selected because they best discriminated anxious from non-anxious subjects in a clinical population (81). The internal consistency and reliability of the 20 items is almost equal to that of the entire 50-item scale (79). A sample item is "I sometimes feel that I am about to go to pieces." The second measure was the Marlowe-Crowne Social Desirability Scale (82). Though a poor measure of social conformity, this 33-item questionaire accurately predicts self-denial or suppression of personal desires and emotions when in conflict with the needs of others or of society (83). A sample item is "I never hesitate to go out of my way to help someone in trouble." The Marlowe-Crowne scale is correlated only minimally with those scales measuring anxiety and distress (82,84).

On the basis of these two scales it is therefore possible to seperate subjects who report experiencing little anxiety (low TMAS) into two groups: those who are accurate in their perceptions (low M-C); and those who are inaccurate in their perceptions (high M-C), denying desires, stressors and emotions (85). The first group can be called "true low anxious" while the second group can be called "repressive" because of their use of a repressive coping style in dealing with life's stressful

experiences. Ultimately four groups can be distinguished based on two personality dimensions: repressive (low TMAS, high M-C), defensive high anxious (high TMAS, high M-C), true high anxious (high TMAS, low M-C), and true low anxious (low TMAS, low M-C). These groupings have been shown by Weinberger, Schwartz and Davidson to be valid constructs reliably distinguishing levels of stress on physiologic and behavioral measures (85). Numerous studies have replicated and validated this typology and used it in cerebral laterality studies (73-75).

Subjects for this study were distributed into personality groups according to parameters previously described in studies with a comparable subject population (86). The four personality groups were defined as follows:

(1) Repressive:	TMAS < 9; M-C > 17
(2) Defensive High Anxious:	TMAS > 8; M-C > 17
(3) True High Anxious:	TMAS > 8; M-C < 18
(4) True Low Anxious:	TMAS < 9; M-C < 18

These personality group parameters resulted in an absence of subjects in the defensive high anxious personality group. Though this result was unexpected, it was believed that any deviation from the accepted cutoffs designated in previous studies would jeapordize the results of this study and its comparison with other research in cerebral laterality and personality type.

RESULTS

The means, standard deviations, and range for the main parameters under investigation are presented in Table I. There was a mean right ear advantage for subjects in all four affect conditions. Pearson correlation coefficients were calculated for the parameters in Table I. There was a positive correlation between right hand score and left hand score ($r=0.52$), an inverse correlation between the handedness score and the left hand score ($r=-0.91$), and a small inverse correlation between the TMAS and the M-C scores ($r=-0.30$). There were also strong positive correlations between the different affect state scores, shown in Table II. No other significant correlations were noted, including any correlations between the affect state scores and the other main parameters of Table I.

Analysis of variance statistical techniques were used to determine significant main effects and interactions of test parameters. An analysis of variance for sex showed no main effect and no significant interactions. The main effect for tape order was also not significant, nor were any interactions. An analysis of variance for affect state, however, revealed a significant main effect of affect or emotion ($F=3.30$; d.f.=3; $p<0.023$). This main effect is primarily generated by the higher perceptual asymmetry scores of the positive:neutral and positive:negative affect conditions, compared to the negative:neutral and neutral:neutral affect conditions. The mean perceptual asymmetry score for

TEST PARAMETER	MEAN	STANDARD DEVIATION	RANGE
Age	22.88	8.256	17 - 51
Right Hand	37.20	2.053	32 - 40
Left Hand	27.20	4.842	17 - 37
Handedness	10.00	4.157	1 - 18
TMAS	7.33	4.626	0 - 20
M-C	11.85	6.087	1 - 28
Perceptual Asymmetry Score Neutral:Neutral	0.0726	0.1372	-0.1818 - 0.3636
Perceptual Asymmetry Score Negative:Neutral	0.0749	0.1211	-0.1363 - 0.3636
Perceptual Asymmetry Score Positive:Neutral	0.1011	0.1117	-0.1591 - 0.4091
Perceptual Asymmetry Score Positive:Negative	0.1138	0.1197	-0.1142 - 0.3571

Table I: Means, standard deviations, and range for test parameters

AFFECT STATES	Negative: Neutral	Positive: Neutral	Positive: Negative
Neutral:Neutral	0.60	0.52	0.70
Negative:Neutral	____	0.58	0.60
Positive:Neutral	____	____	0.55

Table II: Correlations between affect state perceptual asymmetrty scores

neutral:neutral and negative:neutral affect states is 0.0737; while the mean perceptual asymmetry score for positive:neutral and positive:negative affect states is 0.1075. This data, with affect state perceptual asymmetry scores seperated by personality type, is presented graphically in Figure 3 and tabulated in Table III. In Figure 3 we can see that it is the addition of positive affect to the dichotic test which results in a significant increase in perceptual asymmetry scores.

To isolate this effect and measure its statistical significance an analysis of variance using a latin square design with positive and negative affect was constructed. A main effect for positive affect was found ($F=9.66$; d.f.=1; $p<0.004$). There was no main effect for negative affect. Thus, it appears that positive affect is associated with a stronger right ear advantage and increase in perceptual asymmetry in subjects, while the effect of negative affect is not statistically significant.

In order to consider the third hypothesis under investigation in this study an analysis of the interaction of affect state and personality type was designed. From Figure 3 it is evident that the three personality types interact differently with affect states. Consistent with the experimental design of this study, an analysis of variance for personality type was calculated, using perceptual asymmetry scores generated by taking the difference between the affect state scores and the baseline neutral:neutral affect state score. This manipulation corrects for the multitude of factors contributing to variant perceptual asymmetry scores and

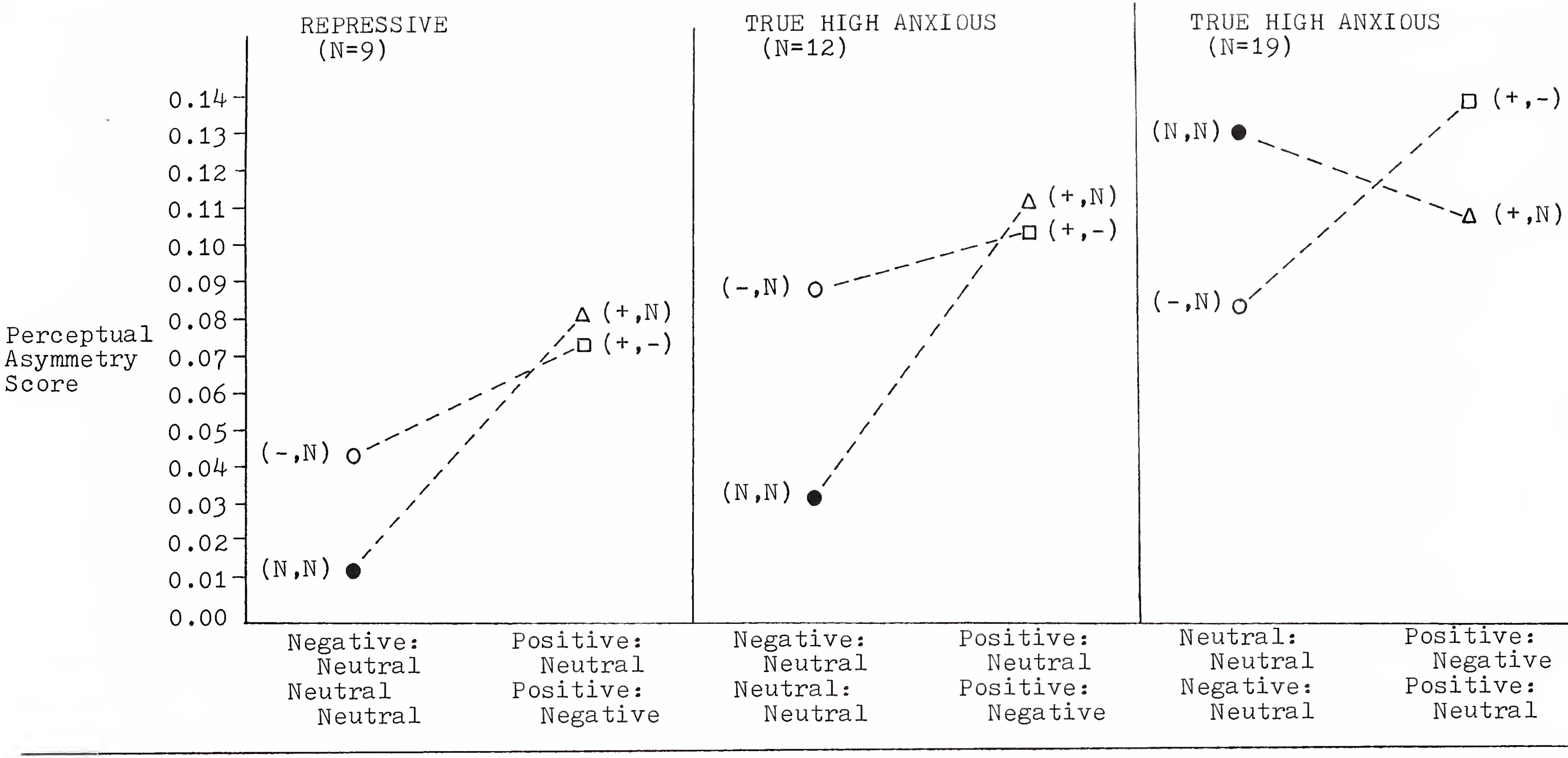

Figure 3: Mean perceptual asymmetry scores for three personality types in four affect states

isolates the effect of affect, allowing for accurate and meaningful comparisons between personality groups. Such an analysis of variance indicates a main effect for personality type ($F=4.59$; d.f.$=2$; $p<0.017$) on the affect dependent changes in perceptual asymmetry. From Figure 3 we can see that repressive and true high anxious subjects show large increases in perceptual asymmetry or laterality with negative, positive, and combined affect states; while true low anxious individuals show a decrease in perceptual asymmetry with negative and positive affect states, and a small increase in perceptual asymmetry with combined affect states. Thus, two differing patterns of response to affect can be described which account for the statistical significance of personality type using perceptual asymmetry difference scores.

An important final observation from Figure 3 is the gradual upward trend in perceptual asymmetry score for the neutral:neutral affect condition across the three personality types. Repressive subjects demonstrate the lowest perceptual asymmetry score in the neutral:neutral affect condition, while true low anxious subjects generate a high perceptual asymmetry score with the same affect test. Consistent with the rationale of personality type laterality studies, true high anxious individuals fall inbetween these two theoretical and apparent extremes. This difference proves to be statistically significant when an analysis of variance using only perceptual asymmetry scores from the neutral:neutral affect condition is calculated. A significant main effect of personality type ($F=3.58$; d.f.$=2$; $p<0.038$) is demonstrated.

An interesting and additional finding from the statistical analyses generated for this study was the very strong main effect of page of dichotic test (1,2,3,4) in an analysis of variance with affect state and personality type ($F=19.80$; $d.f.=3$; $p<0.000$). In addition there was a significant interaction of page of dichotic test with affect state ($F=3.70$; $d.f.=9$; $p<0.000$). Table IV displays the mean perceptual asymmetry scores for each page of the four affect conditions. As can be seen in Table IV, page two of the dichotic tests has the highest mean perceptual asymmetry score, followed by page three, page one, and the small perceptual asymmetry score of page four. This roughly inverted U-shaped pattern of page means varies for different affect conditions however, accounting for the significance of the strong page by affect state interaction. The neutral:neutral affect condition has the highest perceptual asymmetry score on page one, with decreasing scores on pages two, three and four. The negative:neutral and positive:neutral affect conditions demonstrate the inverted U-shape pattern defined by the overall page means, while the positive:negative affect state reverses the position of the highest perceptual asymmetry score between pages two and three.

AFFECT STATES	Repressive	High Anxious	Low Anxious	All Types
Neutral:Neutral	0.0075	0.0318	0.1293	0.0726
Negative:Neutral	0.0440	0.0824	0.0848	0.0749
Positive:Neutral	0.0768	0.1117	0.1058	0.1011
Positive:Negative	0.0725	0.1082	0.1368	0.1138
All Affect Tests	0.0502	0.0835	0.1142	______

Table III: Mean perceptual asymmetry scores for three personality types in four affect states

PAGE	Neutral: Neutral	Negative: Neutral	Positive: Neutral	Positive: Negative	All Affect Tests
Page One	0.1035	0.0293	0.0882	0.0716	0.0732
Page Two	0.1002	0.1055	0.1396	0.1983	0.1359
Page Three	0.0277	0.1614	0.1149	0.1433	0.1193
Page Four	0.0590	0.0034	0.0316	0.0419	0.0340

Table IV: Mean page perceptual asymmetry scores for four affect conditions

DISCUSSION

Dichotic listening tests with positive and negative affect words were used to measure changes in perceptual asymmetry as a function of emotional state. In addition, the possiblity that the effect of emotion on perceptual asymmetry would differ as a function of personality type was evaluated. The presence of positive affect in dichotic tests was linked to an increase in perceptual asymmetry. The presence of negative affect showed no similarly consistent or statistically significant effect. A statistically significant difference in response to affective stimuli was observed in repressive and true high anxious personality types, compared to true low anxious personality types. Finally, the difference between neutral affect test perceptual asymmetry scores in repressive and true high anxious subjects, compared to true low anxious subjects was statistically significant.

The increase in right ear advantage observed with positive affect confirms the first hypothesis under investigation in this study. Explanations for this effect assume that the neural processes serving emotion are relevant to those involved in the sensory processing of dichotic stimuli. With the dichotic presentation of stimuli, it is known that ipsilateral input is inhibited, and that sensory information from both ears is initially processed by the contralateral hemisphere. The right ear gains its perceptual advantage for language-related stimuli

because of the delay and decay of information from the left ear as it transits through the right hemisphere and then across to the language specialized left hemisphere. The large variation in perceptual asymmetry between individuals, and the observed changes in laterality within individuals as a result of changes in stimulus context, suggest that other mechanisms, besides the simple differences in number of synapses and length of neural pathways, contribute to the degree of perceptual asymmetry. That all four affect tests in this study utilize similar sensory processing pathways and association areas is suggested by the positive correlations between affect state perceptual asymmetry scores. Therefore, other mechanisms must be advanced to explain the variation in the magnitude of perceptual asymmetry observed with positive affect.

One mechanism for increasing perceptual asymmetry suggested by this study may be unilateral left hemisphere activation associated with positive emotional processing. Selective activation of the left hemisphere with positive affective stimuli has been suggested by a number of studies of emotional laterality (62-64,66,68). Such activation could facilitate the neural processing of right ear sensory stimuli within the left hemisphere. A compatible explanation, consistent with other known interactive mechanisms in the brain, would be the transcallosal neural inhibition of cognitive processes in the right hemisphere associated with left hemisphere activation. The reciprocal transcallosal inhibition of rival systems of lateralized specialization has been demonstrated for tachistoscopic and dichotic stimuli by Moscovitch (87), and in

an independent study of auditory evoked response by Matsomyia and associates (88).

A mechanism synergistic with left hemisphere activation and transcallosal right hemisphere inhibition is the attenuation of interhemispheric information transfer from the right to the left hemisphere, an explanation derived from the repression/cerebral disconnection hypothesis and consistent with the observed personality by emotion interaction. Repressive and true high anxious subjects both had large increases in laterality with positive and negative affective stimuli. Presumably such affective material is psychologically stressful and evokes a functional disconnection between hemispheres in self-denying individuals. No such change with affective stimuli was observed in true low anxious subjects.

That a functional disconnection between hemispheres exists in repressive individuals has been suggested by a number of laterality studies. These studies have found an increased cerebral asymmetry as measured by facial asymmetry, lateral eye movements, EEG alpha levels and tachistoscopic presentations, with affectively charged stimuli (73-76). That true high anxious subjects demonstrate nearly the same degree of change in perceptual asymmetry with affective stimuli as repressive subjects is not inconsistent with this model or the findings of previous studies. The large changes associated with positive as compared to negative affect are somewhat suprising, since one would expect positive affect to be less psychologically stressful than negative

affect. Though on the surface this relationship would appear intuitively true, the symbolic nature of many positive affective stimuli, particularly those involving sex and pleasure, might prove to be as or even more psychologically stressful to self-denying individuals than negative affective stimuli. Another explanation at work here might be the already discussed synergistic mechanism of left hemisphere activation and transcallosal inhibition compounding the observed increases in perceptual asymmetry with positive affective stimuli. Indeed, the negative affect perceptual asymmetry scores might be artificially low due to a similar but opposite competing mechanism of right hemisphere activation and transcallosal left hemisphere inhibition with negative emotional stimuli. Thus the observed changes in perceptual asymmetry for positive and negative affect might be the result of a combined effect of cerebral disconnection and respective left or right hemisphere activation and contralateral inhibition.

This confirmation of the third hypothesis under investigation is extremely reliable since it requires an examination of the relative relationship between affect test scores for different personality types. Such an examination is independent of the interference of other cognitive processes like stimulus dominance and performance level which can help to define the variation in perceptual asymmetry scores between affect tests. This cognitive variation could conceivably account for a portion or all of the increased perceptual asymmetry observed with positive affect tests. Those tests with positive affect words could simply have

less stimulus dominance within dichotic word pairs than the neutral and negative affect tests. Decreased stimulus dominance in dichotic pairs would lead to increased sensitivity to ear dominance effects and an associated increase in perceptual asymmetry. This explanation is countered, however, by the consistent and symmetrical increase in perceptual asymmetry for positive affect in both the positive:neutral and positive:negative affect tests. Indeed, the positive:negative affect test was minimally pre-tested and was expected to have the largest stimulus dominance effect and poorest dichotic pair fusions of the four affect tests. Stimulus dominance and weak fusions should conspire to mask ear dominance and decrease test sensitivity to perceptual asymmetry. Therefore, the true increase in perceptual asymmetry for the positive:negative affect test could be larger than that actually observed, a finding not inconsistent with the expected result given the repression/cerebral disconnection mechanism and the psychologically stressful nature of the conflictual material presented in the test. Even without such considerations, the positive:negative affect test demonstrated nearly the highest perceptual asymmetry scores across all three personality groups, suggesting that the affectively conflictual material might be stressful enough to trigger some degree of disconnection in even true low anxious individuals.

The failure of the second hypothesis to be statistically confirmed warrants a closer and more detailed examination. That a decrease in perceptual asymmetry with negative affective stimuli was not statistically significant is not suprising, given the

substantial increases in perceptual asymmetry with negative affect seen in repressive and true high anxious subjects compared to their neutral affect perceptual asymmetry scores. These increases, however, might be primarily derived from an overiding inhibition of interhemispheric information transfer seen in the repression/cerebral disconnection mechanism. In true low anxious subjects, who exhibit no disconnection between hemispheres, negative affective stimuli resulted in lower perceptual asymmetry scores than neutral affective stimuli. This finding is consistent with the hypothesized right hemisphere activation and transcallosal inhibition of left hemisphere cognitive processing expected in negative emotional states. Selective activation of the right hemisphere with negative affective stimuli and in depression has been suggested by a number of cerebral laterality studies (58,61,62-64,66,68).

Again, the variation in cognitive content between affect tests needs to be considered as a confounder of results, which makes all comparisons of absolute perceptual asymmetry scores somewhat unreliable. The relative relationship between perceptual asymmetry scores for different personality types is free of such interference, however, and suggests a biphasic response to negative affective material dependent on personality type. In repressive and true high anxious subjects a functional disconnection between hemispheres generates increased laterality, while in true low anxious subjects right hemisphere activation and transcallosal left hemisphere inhibition results in a decrease in perceptual asymmetry. This last finding, although suggested by

the data, is not statistically significant.

Additional evidence for a decreased right ear advantage with negative affect, however, can be derived from an unexpected finding: the statistically significant difference in neutral affect perceptual asymmetry scores between personality types. The low perceptual asymmetry scores for the repressive and true high anxious subjects on the neutral affect test contrasts sharply with the higher perceptual asymmetry scores for the same test in true low anxious individuals. This significant contrast in laterality suggests a different perceived stimulus context for the same neutral affect tests between personality groups. The repressive and true high anxious subjects appear to experience the neutral affect test as a negative stimulus, given their low perceptual asymmetry scores and inclination toward anxiety in a potentially stressful testing environment. The true low anxious subjects meanwhile, as expected, appear to experience the neutral affect test as a truly neutral stimulus, generating significantly higher perceptual asymmetry scores.

In a similar study examining personality type and laterality changes using lateral eye movements, Schwartz and Schwaab found that repressive subjects were relatively more stressed by the laboratory situation in general, and showed an associated increase in right hemisphere activity compared to true low anxious subjects (74). That this effect would also be seen in true high anxious subjects is not suprising given their generally low anxiety thresholds. The low perceptual asymmetry scores on neutral affect

tests for these two personality types provides the statistical evidence needed to confirm right hemisphere activation and transcallosal left hemisphere inhibition with negative stimuli, resulting in a decrease in perceptual asymmetry for these individuals.

Another unexpected finding was the large page effect observed for the dichotic tests. This effect is suspiciously symmetric with the changing channel presentation of earphones during dichotic testing. Earphone direction was reversed after page one and page three of the dichotic tests. Any auditory asymmetry in the presentation of stimuli in the earphones could result in a channel effect, creating the observed differences in perceptual asymmetry between pages one and four and pages two and three. The high perceptual asymmetry scores for pages two and three would be the result of increased stimulus dominance, probably secondary to increased acoustic volume, for words then being presented to the right ear; adding to any already present advantage for right ear stimuli. The low perceptual asymmetry scores for pages one and four would be the result of increased stimulus dominance for words being presented to the left ear, competing directly with ear dominance for right ear words. Strict procedures and controls during tape design and computer generated construction virtually guarantee the auditory symmetry of dichotic pairs on the actual tape. Exacting equipment specifications and calibrations during testing permit no detectable asymmetry in the presentation of dichotic pairs to subjects. Still, the differences in perceptual asymmetry measured are very small on an absolute scale, on the

order of one word difference per page, and the tiniest auditory asymmetry could account for the observed page effect. Any channel effect on affect test perceptual asymmetry scores, however, would be balanced by the equal distribution of dichotic pairs for each channel during presentation of stimuli.

Another possible explanation for page effect is suggested however, by the significant page by affect state interaction. The neutral affect test shows no evidence of a channel effect. The decreasing perceptual asymmetry score with increasing page on the neutral test suggests a habituation to stimulus presentation and/or ear dominance effect. The inverted U-shape of the other affect tests with explicit positive and negative stimuli could indicate a sensitization to the affective content of such stimuli, followed by a habituation. This response would correspond with the expected cerebral disconnection response to affective stimuli, increasing with the cognitive build-up of affective material, and then releasing once a sort of tolerance had been achieved. These conclusions are highly speculative, however, and warrant a more controlled and careful examination. Future dichotic testing experiments could reverse earphone direction at different intervals to more accurately assess any potential channel or habituation/sensitization effect.

It is possible to describe these observed changes in perceptual asymmetry as shifts in attentional bias toward one or the other hemisphere, and thereby to include them in a more general psychological theory of attentional alterations. While dichotic

listening could probably be used to investigate such psychological hypotheses, it was the intent of this study to consider changes in perceptual asymmetry in terms of cerebral anatomy and functional neurology. Instead of shifts in attention, this investigation considers the relative activity of each cerebral hemisphere, or the degree of inhibition of one hemisphere by the other. Such a conceptualization is independent of psychological theories and bias, and looks directly and precisely at brain function and interaction.

In conclusion, data generated by this experiment in dichotic listening supported the three hypotheses under investigation. The interaction of the proposed cerebral mechanisms in determining the degree of perceptual asymmetry should have been anticipated, and made the interpretation of results complex, but congruent with reasonable expectations and predictions derivable from previous studies. Thus, positive affect did increase perceptual asymmetry, a result of (1) interhemispheric disconnection and (2) left hemisphere activation and right hemisphere inhibition in repressive and true high anxious individuals; but a solitary result of left hemisphere activation and right hemisphere inhibition in true low anxious subjects. Negative affect and its resultant right hemisphere activation and left hemisphere inhibition did decrease perceptual asymmetry; an effect observable in true low anxious individuals, but masked by disconnection effects in repressive and true high anxious subjects. The low perceptual asymmetry scores for neutral affect tests in repressive and true high anxious subjects, compared to true low anxious

subjects, is suggestive of right hemisphere activation and left hemisphere inhibition with negative affect, since the testing situation is interpreted as a negative stimulus by self-denying individuals.

These effects, though difficult to sort out, integrate nicely and suggest an elegant and precise effect and interaction of affect and personality type in normal brain function. These findings support the more recently proposed lateralization of emotion; with negative affect associated with the right hemisphere and positive affect with the left hemisphere. The findings of this study also support the repression/cerebral disconnection hypothesis and its proposed interaction with emotion. Most importantly, this study affirms the use of dichotic listening tests with affective words as a measure of perceptual asymmetry to explore the actions and interactions of emotion and personality type as they relate to brain function. A replication of these results in a seperate study using a different combination and set of affect tests, and a defensive high anxious personality group, would confirm and amplify the present findings and conclusions. The application of this experimental methodology to the investigation of psychiatric illness could provide new perspectives and tools for discerning disorders of brain function. One can only hope that the non-invasive elegance and ease of studies in cerebral laterality will only grow in application and scope in the pursuit of greater understanding of brain function and dysfunction.

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Appendix A

PREPARED ANSWER SHEETS FOR FOUR AFFECT TESTS WITH PRACTICE SEGMENTS

Neutral:Neutral Affect Test Practice Segment: Page One

1. tad
2. pad
3. dill
4. dub
5. gong
6. tell
7. tug
8. ban
9. dan
10. gill
11. bean
12. dong
13. tape
14. coot
15. pug
16. cape
17. tap
18. dean
19. toot
20. cap
21. pell
22. bub

NNATPS: Page Two

23.	tell	dell	pell	bell
24.	toot	coot	boot	hoot
25.	dub	hub	bub	pub
26.	tad	gad	cad	pad
27.	dean	teen	bean	mean
28.	kong	dong	bong	gong
29.	pug	dug	tug	bug
30.	bug	dug	pug	tug
31.	tape	cape	nape	gape
32.	pill	dill	gill	nill
33.	gong	dong	bong	kong
34.	gape	tape	nape	cape
35.	nap	cap	tap	gap
36.	mean	dean	teen	bean
37.	nill	pill	dill	gill
38.	boot	hoot	coot	toot
39.	pan	ban	can	dan
40.	pub	bub	dub	hub
41.	tap	gap	cap	nap
42.	can	pan	ban	dan
43.	pell	dell	tell	bell
44.	cad	pad	tad	gad

Neutral:Neutral Affect Test: Page One

1.	pill	dill	gill	nill
2.	dong	bong	kong	gong
3.	teen	mean	dean	bean
4.	tell	pell	bell	dell
5.	dan	pan	ban	can
6.	pad	tad	cad	gad
7.	cap	tap	nap	gad
8.	cape	nape	tape	gape
9.	coot	toot	boot	hoot
10.	kong	gong	bong	dong
11.	bub	hub	pub	dub
12.	tug	bug	pug	dug
13.	gad	tad	cad	pad
14.	pell	dell	tell	bell
15.	dean	teen	bean	mean
16.	dill	pill	gill	nill
17.	hoot	coot	toot	boot
18.	pub	hub	dub	bub
19.	can	dan	pan	ban
20.	pug	tug	dug	bug
21.	cap	gap	nap	tap
22.	gape	tape	cape	nape

NNAT: Page Two

23.	gad	pad	cad	tad
24.	pad	tad	gad	cad
25.	dill	gill	pill	nill
26.	dub	pub	hub	bub
27.	dong	gong	bong	kong
28.	pell	bell	tell	dell
29.	dug	bug	pug	tug
30.	can	pan	ban	dan
31.	dan	pan	ban	can
32.	dill	nill	pill	gill
33.	dean	mean	teen	bean
34.	bong	dong	kong	gong
35.	nape	cape	gape	tape
36.	toot	coot	hoot	boot
37.	tug	bug	dug	pub
38.	cape	gape	nape	tape
39.	cap	nap	gap	tap
40.	bean	mean	teen	dean
41.	toot	hoot	coot	boot
42.	gap	tap	nap	cap
43.	dell	bell	tell	pell
44.	pub	dub	hub	bub

NNAT: Page Three

45.	dell	pell	bell	tell
46.	toot	hoot	boot	coot
47.	dub	bub	pub	hub
48.	cad	pad	tad	gad
49.	dean	bean	mean	teen
50.	dong	kong	gong	bong
51.	pug	bug	dug	tug
52.	bug	dug	pug	tug
53.	gape	cape	nape	tape
54.	nill	pill	gill	dill
55.	dong	gong	kong	bong
56.	nape	gape	cape	tape
57.	tap	cap	gap	nap
58.	mean	dean	bean	teen
59.	nill	pill	dill	gill
60.	coot	hoot	toot	boot
61.	can	pan	dan	ban
62.	hub	bub	dub	pub
63.	tap	gap	cap	nap
64.	ban	pan	dan	can
65.	pell	bell	dell	tell
66.	gad	cad	pad	tad

NNAT: Page Four

67.	nape	tape	gape	cape
68.	teen	bean	dean	mean
69.	teen	dean	bean	mean
70.	dong	kong	bong	gong
71.	dill	gill	nill	pill
72.	pub	dub	bub	hub
73.	nap	gap	cap	tap
74.	coot	hoot	boot	toot
75.	tad	gad	cad	pad
76.	can	dan	ban	pan
77.	dong	bong	kong	gong
78.	dill	gill	pill	nill
79.	coot	toot	hoot	boot
80.	gad	tad	cad	pad
81.	dug	pug	bug	tug
82.	bell	tell	dell	pell
83.	nape	cape	tape	gape
84.	pub	bub	hub	dub
85.	can	ban	dan	pan
86.	tell	bell	pell	dell
87.	nap	tap	gap	cap
88.	pug	bug	tug	dug

Negative:Neutral Affect Test Practice Segment: Page One

1. door
2. pad
3. door
4. bad
5. ton
6. till
7. died
8. ted
9. gore
10. bide
11. bag
12. gun
13. mad
14. bore
15. kill
16. dead
17. nag
18. pad
19. bitch
20. ditch
21. core
22. gore

NegNATPS: Page Two

23. till	pill	gill	kill
24. bore	core	door	gore
25. ned	dead	ted	bed
26. gag	tag	nag	bag
27. pun	bun	ton	gun
28. ditch	hitch	bitch	pitch
29. tad	pad	mad	gad
30. gill	till	kill	pill
31. bitch	ditch	hitch	pitch
32. gag	nag	bag	tag
33. mad	tad	gad	pad
34. core	bore	door	gore
35. tore	door	core	gore
36. tore	core	door	gore
37. bide	died	hide	tied
38. hide	died	bide	tied
39. bad	pad	dad	gad
40. door	tore	core	bore
41. bed	dead	ned	ted
42. bun	gun	ton	pun
43. tore	door	core	bore
44. pad	dad	gad	bad

Negative:Neutral Affect Test: Page One

1.	tag	gag	bag	nag
2.	tore	door	core	gore
3.	ned	dead	bed	ted
4.	gad	pad	mad	tad
5.	bad	dad	gad	pad
6.	core	bore	tore	door
7.	nag	gag	bag	tag
8.	kill	till	gill	pill
9.	bad	pad	dad	gad
10.	pill	till	gill	kill
11.	gun	pun	ton	bun
12.	pitch	bitch	ditch	hitch
13.	pad	mad	tad	gad
14.	bore	door	tore	core
15.	died	tied	hide	bide
16.	tied	bide	hide	died
17.	door	bore	core	gore
18.	ditch	bitch	pitch	hitch
19.	ted	ned	bed	dead
20.	ton	bun	pun	gun
21.	door	gore	core	bore
22.	door	core	tore	gore

NegNAT: Page Two

23.	door	core	tore	bore
24.	mad	gad	tad	pad
25.	bore	core	gore	door
26.	pad	dad	bad	gad
27.	gun	pun	ton	bun
28.	kill	till	pill	gill
29.	died	tied	hide	bide
30.	ted	ned	dead	bed
31.	door	bore	core	gore
32.	tied	bide	hide	died
33.	nag	tag	bag	gag
34.	pun	gun	bun	ton
35.	pad	tad	gad	mad
36.	bore	door	core	tore
37.	gill	pill	till	kill
38.	dead	ned	ted	bed
39.	bag	nag	tag	gag
40.	dad	bad	gad	pad
41.	pitch	hitch	bitch	ditch
42.	hitch	ditch	pitch	bitch
43.	gore	core	door	tore
44.	core	tore	gore	door

NegNAT: Page Three

45.	till	kill	gill	pill
46.	bore	core	gore	door
47.	ned	ted	bed	dead
48.	tag	bag	nag	gag
49.	ton	bun	pun	gun
50.	hitch	ditch	bitch	pitch
51.	mad	pad	gad	tad
52.	kill	pill	till	gill
53.	bitch	hitch	pitch	ditch
54.	bag	gag	tag	nag
55.	pad	mad	gad	tad
56.	door	bore	gore	core
57.	door	gore	tore	core
58.	tore	door	core	gore
59.	died	hide	bide	tied
60.	died	tied	hide	bide
61.	dad	pad	bad	gad
62.	door	bore	tore	core
63.	bed	ned	dead	ted
64.	pun	gun	bun	ton
65.	tore	core	bore	door
66.	bad	gad	pad	dad

NegNAT: Page Four

67.	died	hide	tied	bide
68.	dad	gad	pad	bad
69.	nag	gag	bag	tag
70.	ted	dead	ned	bed
71.	tore	door	gore	core
72.	core	gore	bore	door
73.	ton	gun	bun	pun
74.	mad	tad	gad	pad
75.	pad	bad	gad	dad
76.	ned	bed	ted	dead
77.	pad	tad	gad	mad
78.	hitch	pitch	ditch	bitch
79.	core	door	bore	tore
80.	kill	pill	till	gill
81.	core	tore	door	gore
82.	bide	died	tied	hide
83.	bore	core	door	gore
84.	bitch	hitch	pitch	ditch
85.	ton	bun	gun	pun
86.	pill	kill	till	gill
87.	gag	tag	nag	bag
88.	door	core	tore	bore

Positive:Neutral Affect Test Practice Segment: Page One

1. ton
2. tweet
3. hug
4. tall
5. kissed
6. take
7. tug
8. could
9. pan
10. doll
11. good
12. god
13. balm
14. cod
15. sweet
16. fun
17. cake
18. palm
19. gist
20. tan
21. dad
22. gad

PNATPS: Page Two

23.	cake	make	take	bake
24.	doll	ball	gall	tall
25.	calm	palm	balm	psalm
26.	god	mod	pod	cod
27.	sweet	tweet	meet	beat
28.	pod	cod	god	mod
29.	make	cake	take	bake
30.	tug	dug	hug	bug
31.	psalm	calm	palm	balm
32.	sweet	meet	beat	tweet
33.	tall	ball	doll	gall
34.	fan	tan	can	pan
35.	tad	dad	gad	pad
36.	dug	bug	tug	hug
37.	dad	tad	gad	pad
38.	could	good	should	hood
39.	pan	can	tan	fan
40.	good	hood	could	should
41.	kissed	hissed	pissed	gist
42.	bun	ton	pun	fun
43.	bun	ton	pun	fun
44.	kissed	pissed	hissed	gist

Positive:Neutral Affect Test: Page One

1.	psalm	palm	calm	balm
2.	pad	gad	tad	dad
3.	sweet	meet	best	tweet
4.	bug	hug	tug	dug
5.	pissed	hissed	gist	kissed
6.	fun	ton	pun	bun
7.	palm	psalm	balm	calm
8.	pod	mod	cod	god
9.	bake	take	make	cake
10.	kissed	gist	hissed	pissed
11.	take	cake	bake	make
12.	pod	cod	god	mod
13.	meet	sweet	tweet	beat
14.	bug	tug	dug	hug
15.	bun	ton	fun	pun
16.	could	good	should	hood
17.	good	could	should	hood
18.	gall	doll	tall	ball
19.	tall	ball	doll	gall
20.	tan	fan	pan	can
21.	fan	can	pan	tan
22.	dad	gad	pad	tad

PNAT: Page Two

23.	bun	fun	ton	pun
24.	meet	beat	sweet	tweet
25.	hug	bug	tug	dug
26.	ball	gall	doll	tall
27.	pissed	gist	hissed	kissed
28.	bake	make	cake	take
29.	dug	hug	tug	bug
30.	good	should	hood	could
31.	can	pan	tan	fan
32.	ball	doll	gall	tall
33.	should	hood	good	could
34.	mod	god	pod	cod
35.	calm	palm	balm	psalm
36.	god	pod	cod	mod
37.	beat	meet	tweet	sweet
38.	pun	bun	ton	fun
39.	cake	take	make	bake
40.	calm	psalm	balm	palm
41.	kissed	pissed	hissed	gist
42.	tan	fan	pan	can
43.	pad	tad	gad	dad
44.	gad	tad	dad	pad

PNAT: Page Three

45.	bake	cake	take	make
46.	gall	doll	tall	ball
47.	balm	calm	palm	psalm
48.	cod	mod	pod	god
49.	meet	tweet	beat	sweet
50.	cod	god	pod	mod
51.	bake	cake	make	take
52.	dug	bug	tug	hug
53.	balm	palm	psalm	calm
54.	beat	tweet	sweet	meet
55.	tall	gall	ball	doll
56.	pan	fan	can	tan
57.	dad	pad	tad	gad
58.	hug	bug	dug	tug
59.	pad	gad	dad	tad
60.	good	should	could	hood
61.	can	pan	tan	fan
62.	should	good	hood	could
63.	hissed	gist	kissed	pissed
64.	fun	pun	bun	ton
65.	ton	pun	fun	bun
66.	pissed	hissed	kissed	gist

PNAT: Page Four

67.	could	should	good	hood
68.	god	cod	pod	mod
69.	kissed	pissed	hissed	gist
70.	palm	balm	calm	psalm
71.	pad	dad	tad	gad
72.	tall	gall	ball	doll
73.	tweet	sweet	beat	meet
74.	hug	dug	tug	bug
75.	hissed	kissed	gist	pissed
76.	hug	tug	dug	bug
77.	tweet	sweet	meet	beat
78.	pun	ton	fun	bun
79.	cake	make	take	bake
80.	can	pan	fan	tan
81.	dad	gad	tad	pad
82.	should	could	good	hood
83.	tall	ball	gall	doll
84.	cod	mod	pod	god
85.	make	take	bake	cake
86.	balm	psalm	palm	calm
87.	can	tan	pan	fan
88.	ton	pun	bun	fun

Positive:Negative Affect Test Practice Segment: Page One

1. kiss
2. purred
3. kite
4. stream
5. pert
6. bane
7. pie
8. sky
9. sty
10. fight
11. scream
12. bed
13. test
14. bad
15. best
16. turd
17. hurt
18. die
19. dead
20. dad
21. piss
22. gain

PNegATPS: Page Two

23.	nest	best	test	jest
24.	bert	dirt	pert	hurt
25.	dream	stream	scream	cream
26.	kite	might	height	fight
27.	my	pie	die	tie
28.	hiss	miss	piss	kiss
29.	ned	ted	dead	bed
30.	height	might	kite	fight
31.	best	jest	test	nest
32.	purred	turd	bird	herd
33.	main	bane	dane	gain
34.	turd	herd	purred	bird
35.	high	buy	sty	sky
36.	piss	hiss	miss	kiss
37.	gain	main	bane	dane
38.	high	sky	buy	sty
39.	tie	die	my	pie
40.	tad	pad	dad	bad
41.	dirt	hurt	pert	bert
42.	pad	tad	bad	dad
43.	bed	ted	ned	dead
44.	stream	cream	dream	scream

Positive:Negative Affect Test: Page One

1.	scream	dream	cream	stream
2.	kiss	piss	miss	hiss
3.	gain	main	bane	dane
4.	tie	die	my	pie
5.	jest	test	best	nest
6.	kite	fight	height	might
7.	pad	bad	dad	tad
8.	dirt	bert	pert	hurt
9.	purred	herd	turd	bird
10.	pert	dirt	hurt	bert
11.	fight	might	height	kite
12.	ted	bed	dead	ned
13.	bird	turd	herd	purred
14.	stream	cream	scream	dream
15.	buy	sty	sky	high
16.	my	pie	tie	die
17.	tad	dad	bad	pad
18.	test	jest	nest	best
19.	bed	ned	dead	ted
20.	buy	sty	high	sky
21.	bane	main	gain	dane
22.	hiss	miss	kiss	piss

PNegAT: Page Two

23.	piss	kiss	miss	hiss
24.	bird	purred	turd	herd
25.	fight	height	kite	might
26.	stream	dream	cream	scream
27.	pert	bert	dirt	hurt
28.	dane	gain	main	bane
29.	my	die	pie	tie
30.	high	sky	sty	buy
31.	sky	high	sty	buy
32.	height	kite	fight	might
33.	dream	scream	cream	stream
34.	ted	dead	bed	ned
35.	test	best	jest	nest
36.	pad	tad	dad	bad
37.	best	test	nest	jest
38.	bird	herd	purred	turd
39.	dirt	bert	pert	hurt
40.	die	pie	tie	my
41.	ted	dead	bed	ned
42.	tad	bad	dad	pad
43.	piss	kiss	hiss	miss
44.	main	dane	bane	gain

PNegAT: Page Three

45.	best	test	nest	jest
46.	dirt	pert	hurt	bert
47.	scream	dream	stream	cream
48.	kite	fight	might	height
49.	tie	pie	my	die
50.	miss	hiss	kiss	piss
51.	bed	ted	ned	dead
52.	fight	kite	might	height
53.	best	jest	nest	test
54.	turd	bird	herd	purred
55.	main	gain	dane	bane
56.	turd	bird	herd	purred
57.	high	sky	sty	buy
58.	kiss	piss	hiss	miss
59.	main	bane	dane	gain
60.	high	buy	sty	sky
61.	my	die	pie	tie
62.	bad	pad	dad	tad
63.	hurt	pert	bert	dirt
64.	pad	dad	bad	tad
65.	bed	ned	dead	ted
66.	dream	scream	stream	cream

PNegAT: Page Four

67.	bane	main	dane	gain
68.	stream	dream	scream	cream
69.	dad	tad	bad	pad
70.	dirt	pert	bert	hurt
71.	dirt	hurt	pert	bert
72.	ned	bed	dead	ted
73.	tad	bad	pad	dad
74.	bird	purred	herd	turd
75.	buy	high	sky	sty
76.	hiss	miss	piss	kiss
77.	best	jest	nest	test
78.	fight	might	height	kite
79.	jest	test	nest	best
80.	buy	sty	high	sky
81.	height	might	kite	fight
82.	bird	turd	purred	herd
83.	piss	kiss	hiss	miss
84.	scream	cream	dream	stream
85.	my	pie	tie	die
86.	my	tie	pie	die
87.	main	bane	gain	dane
88.	ned	dead	bed	ted

Appendix B

INSTRUCTIONS FOR THE FUSED RHYMED WORDS TEST

Instructions for Practice Page One:

Before you is a list of 22 words. On the tape you will hear a man's voice which will say these same words in the exact order that they appear on your list. All you have to do is put a check next to each word if you have heard the word correctly. The purpose of this is to familiarize you with these words and how they sound.

Instructions for Practice Page Two:

Now as you see, there are 4 words on each of the 22 lines on this answer sheet. Again you will hear a man's voice reading a list of words. Choose the word you think you hear out of the 4 alternatives and put a line through the word.

Instructions for Affect Test Pages 1, 2, 3 and 4:

The words in this part of the test have deliberately been made more difficult to make out. This is part of the test so don't be concerned if you are unsure about some of them. Just try your best to pick out the word you heard from the 4 alternatives and put a line through the word. If you are unsure, guess.

Appendix C

QUESTIONAIRE OF MANUAL AYSMMETRY

Directions:

Answer each question carefully. However, before answering quickly have a go at the task described. For some questions this will be easy to do, for others you will have to act out the task as if you had some object or instrument in your hand. To answer each question you will be required to PLACE A CROSS (X) on a line at a point you consider the most appropriate. The possible choices provided include: WITH MUCH DIFFICULTY, WITH SOME DIFFICULTY, WITH SLIGHT EFFORT, EASILY, VERY EASILY. The following examples illustrate the types of questions you will be asked and possible answers you might give:

EXAMPLE QUESTIONS AND ANSWERS:

A. How easily could you insert a drawing pin into a hard notice board, using your RIGHT HAND?

B. How easily could you throw a ball to hit a target, using your LEFT HAND?

In the first example the answer (X) indicates that the RIGHT HAND could "easily" perform the task, but that it could not do it "very easily." In example B the LEFT HAND perfomed the task with some difficulty.

REMEMBER: Quickly act out each question before answering.

1. If you had to be fast, how easily could you screw a nut onto a bolt if you turned THE NUT with your RIGHT HAND?

2. How easily could you peel an orange, if you held THE ORANGE in your LEFT HAND?

3. How easily could you deal out a pack of cards, if you held THE PACK in your RIGHT HAND?

4. If you had to be quick, how easily could you turn on a water tap, using your LEFT HAND?

5. How easily could you clean your teeth if you held the toothbruch in your RIGHT HAND?

6. How easily could you scratch an itch on the center of your back, using your LEFT HAND?

7. If you had to tap a button very fast, how easily could you do this using the INDEX FINGER (next to the thumb) of your RIGHT HAND?

8. If you wished to check that it was not too hot, how easily could you sip a cup of tea, if you held the handle of the cup in your RIGHT HAND?

9. If you had to accurate, how easily could you tell by touch alone (out of sight) if the texture of two pieces of fabric were the same, using your LEFT HAND?

10. If you had to make a loud "clicking" noise with your thumb and fingers, how easily could you do this using the thumb and the THIRD FINGER (next to the little finger) of your LEFT HAND?

11. How easily could you wipe a dish with a towel, if you held THE TOWEL in your RIGHT HAND?

12. How easily could you pour liquid from a small bottle onto a spoon without spilling any, if you held THE SPOON in your RIGHT HAND?

13. If you had to be quick, how easily could you take the cap off a bottle if you held THE BOTTLE in your RIGHT HAND?

14. How easily could you use a knife to cut an apple into two parts, if you held THE KNIFE in your RIGHT HAND?

15. How easily could you unscrew a lid from a jar, if you held THE JAR in your RIGHT HAND?

16. How easily could you draw a square using your RIGHT HAND?

Appendix D

BENDIG SHORT FORM OF THE TAYLOR MANIFEST ANXIETY SCALE AND MARLOWE-CROWNE SOCIAL DESIRABILITY SCALE

Please read each statement and decide whether you feel in general that it is mostly true as applied to you or mostly false. Please circle the appropriate letter (T-true, F-false) directly to the right of each statement. Answer "True" to positively stated questions if they are true as often or more often than stated. For example, answer "True" to "Occasionally, I play poker" if you play occasionally or more often.

1. I find it hard to keep my mind on a task or job.
2. I am sometimes irritated by people who ask favors of me.
3. I am happy most of the time.
4. Before voting, I thoroughly investigate the qualifications of all the candidates.
5. I believe I am no more nervous than most others.
6. I sometimes think when people have a misfortune they only got what they deserved.
7. I am more sensitive than most people.
8. I like to gossip at times.
9. On occasion I have had doubts about my ability to succeed in life.
10. There have been occasions when I took advantage of someone.
11. I am a high-strung person.
12. I have never intensely disliked anyone.
13. I cannot keep my mind on one thing.
14. I never make a long trip without checking the safety of my car.
15. I have periods of such great restlessness that I cannot sit long in a chair.
16. I am always courteous, even to people who are disagreeable.

17. On a few occasions, I have given up doing something because I thought too little of my ability.

18. I am always careful about my manner of dress.

19. At times I think I am no good at all.

20. I have never felt that I was punished without cause.

21. When I don't know something, I don't at all mind admitting it.

22. I am usually calm and not easily upset.

23. I never resent being asked to return a favor.

24. I am not unusually self-conscious.

25. I sometimes try to get even, rather than forgive and forget.

26. If I could get into a movie without paying and be sure I was not seen, I would probably do it.

27. I work under a great deal of tension.

28. I have never deliberately said something that hurt someone's feelings.

29. I can remember "playing sick" to get out of something.

30. I am inclined to take things hard.

31. I sometimes feel resentful when I don't get my way.

32. Life is a strain for me much of the time.

33. No matter who I'm talking to, I'm always a good listener.

34. I certainly feel useless at times.

35. I always try to practice what I preach.

36. There have been times when I was quite jealous of the good fortune of others.

37. I sometimes feel that I am about to go to pieces.

38. I have never been irked when people expressed ideas very different from my own.

39. My table manners at home are as good as when I eat out in a restaurant.

40. There have been occasions when I felt like smashing things.

41. I have sometimes felt that difficulties were piling up so high that I could not overcome them.

42. I never hesitate to go out of my way to help someone in trouble.

43. It is sometimes hard for me to go on with my work if I am not encouraged.

44. At times I have really insisted on having things my own way.

45. I feel anxiety about something or someone almost all the time.

46. I'm always willing to admit it when I make a mistake.

47. There have been times when I felt like rebelling against people in authority even though I knew they were right.

48. I frequently find myself worrying about something.

49. I have almost never felt the urge to tell someone off.

50. I shrink from facing a crisis or difficulty.

51. I don't find it particularly difficult to get along with loud-mouthed, obnoxious people.

52. I am certainly lacking in self-confidence.

53. I would never think of letting someone else be punished for my wrong-doings.

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